



General Radio

Glen I. Personett
Engineer

Telephone: 513-294-1500
3300 SOUTH DIXIE DRIVE
DAYTON, OHIO 45439

INDIANA, KENTUCKY, Telephone: 317-898-8063

GR COMPANIES:
Grason-Stadler
Time/Data

General Radio



PRELIMINARY MANUAL

Type 1062
Frequency Synthesizer

A



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PRELIMINARY MANUAL

Type 1062 Frequency Synthesizer

A

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Form 1062-0100-A

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ID-0100-A

Specifications

Fixed Frequency: 10 kHz to 500 MHz in 10-kHz steps with 100-Hz search-sweep settability. Finer steps optional, the finest being 0.1-Hz steps with 0.001-Hz search-sweep settability. **LOCAL CONTROL (Option 1):** Set by in-line-readout panel switches or external remote-control signals; control transferred by single panel control. **REMOTE CONTROL:** Set by 8-4-2-1 external signals; logic "1" is 0 to 0.5 V at 3 mA, logic "0" is +5 V at 0 mA. Programming time < 100 μ s per step except with economy resolution options (4F or 4G), where it is $\approx$ 5 ms for steps below 10 kHz.

Search-sweep and Frequency Modulation — (limited with economy resolution options 4F and 4G): **SWEEP WIDTH:** Up to 11 MHz. Any decade, with 1-MHz steps or less, can be replaced by a continuous control with a range of -1 to $+10 \times$ one step of the decade being replaced, with a settability of $1/100$ of one step. **LOCAL CONTROL (Optional):** Digit to be replaced is chosen by panel pushbuttons or external signal; frequency is set by -1 to $+10$ multiplier plus continuous vernier or by external signal. **REMOTE CONTROL:** Digit to be replaced is chosen by logic signal; frequency is set by $+0.5$ V/step (-0.5 to $+5.0$ V) dc signal with nonlinearity of ± 0.3 step max. **SWEEP (FM) RATE:** Dc to 20 kHz, -3 dB. **DEVIATION pk-pk:** Same as sweep width. **HARMONIC DISTORTION:** < 6% for all deviations within range of decade selected. **STABILITY:** $\pm 2 \times 10^{-4}$ step, $\pm 1 \times 10^{-3}$ step/min, $\pm 1 \times 10^{-2}$ step/h. **AMPLITUDE MODULATION:** Dc to 1 kHz at 90% modulation, dc to 10 kHz at 15% modulation; with 5% distortion. Control via remote-control of signal output (see below), achieved by externally summing an a-m rate source with a dc voltage.

Signal Output: 100 mV to 1.00 V rms (-7 to $+13$ dBm into 50 Ω) from 50- Ω source, available at rear GR874 connector (optionally on front panel). **LOCAL CONTROL (optional):** Set by panel control with ± 1.5 -dB accuracy or by external remote-control signal. **REMOTE CONTROL:** Set by external dc signal of 4 X desired rms output voltage, into > 10 k Ω applied to rear BNC connector. Programming time < 100 μ s, to desired level within ± 1 dB.

Auxiliary Outputs: 10 MHz at 500 mV $\pm 20\%$ into 50 Ω which can be used to drive another synthesizer and 1 MHz at 0.8 V pk-pk into 10 k Ω , available at rear BNC connectors. Also, 42, 500 to 510 MHz, 1.8 to 2.2 and 2.2 to 2.3 GHz available at rear SMA connectors for special applications.

Phase Modulation (optional): Output can be phase modulated ± 3 rad from dc to 300 kHz, ± 1 rad at 1-MHz modulation frequency, by external signal of 1 V/rad at dc, flat within 2 dB to 300 kHz, into 7.5 k Ω , applied to rear BNC connector.

Accuracy of Fixed Frequency: Equal to that of drive source. Drive source can be internal oscillator or external drive.

Internal Oscillator (optional): **MODERATE STABILITY:** 5-MHz crystal oscillator. Adjustment range > 5×10^{-5} by manual trimmer or > 5×10^{-6} by $+6$ - to $+9$ -V external dc signal. Stability is $2 \times 10^{-7}/^\circ\text{C}$ from $+20$ to $+50^\circ\text{C}$ $2 \times 10^{-6}/\text{mo}$. **HIGH STABILITY:** 10-MHz crystal oscillator in proportional-control oven. Adjustment range, > 4×10^{-6} by manual trimmer or > 5×10^{-7} by $+6$ - to $+9$ -V external dc signal. Stability, < $2 \times 10^{-10}/^\circ\text{C}$ from 0 to $+50^\circ\text{C}$. Drift, $\pm 1 \times 10^{-8}/\text{wk}$, < 2×10^{-10} with $\pm 10\%$ line-voltage variation, restabilizes within 2 h after power interruption. Connector provided on rear for battery to maintain oscillator during power interruption.

External Drive (required on models without internal oscillator): 5 or 10 MHz, 130 mV to 2.5 V rms into 50 Ω applied to rear BNC connector.

Environment: **TEMPERATURE:** 0 to $+50^\circ\text{C}$ operating.

Supplied: Power cord, coaxial patch cord with GR874 connectors, 50-pin plug to mate with rear connector.

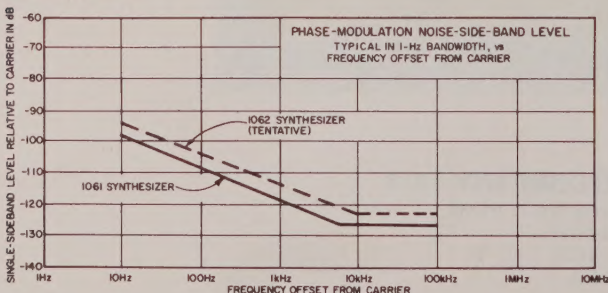
Available: GR874 adaptors, 1452 Programmable Attenuator.

Power: 90 to 110, 104 to 127, 180 to 220, 194 to 236, or 207 to 253 V; 48 to 66 Hz (45 to 48 Hz with high-line limit decreased 5%, 360 to 440 Hz with low-line limit increased 5%); 70 W max. Connection provided for 15- to 18-V, 200-mA, dc source to maintain high-stability oscillator during power interruption.

Mechanical: Bench or rack models. **DIMENSIONS (wxhxd):** Bench, 19.75x6.9x24.88 in. (502x176x632 mm); rack, 19x5.22x22.88 in. (483x133x569 mm). **WEIGHT:** Bench, 58 lb (27 kg) net, 69 lb (32 kg) shipping; rack, 50 lb (23 kg) net, 61 lb (28 kg) shipping.

Output Level (freq response) full output	± 0.6 dB
Harmonics, 50- Ω load	-27 dB
Discrete Non-Harmonics	-80 dB
Noise Modulation phase, rms*	-63 dB re 1 rad (0.5 to 15 kHz)
amplitude, rms	-75 dB re 100% (0.5 to 15 kHz)

* Also see curve.



Description	Catalog Number
1062 Frequency Synthesizer, 10 kHz to 500 MHz with 10-kHz resolution and 100-Hz search settability, remote control, and external drive only	
Bench Model	
Rack Model	
Options	
OP1 Local Control Panel	
OP2A Moderate-Stability Internal Oscillator	
OP2B High-Stability Internal Oscillator	
OP3 Phase Modulation	
OP4A 1-kHz digit resolution (10-Hz search)	
OP4B 100-Hz digit resolution (1-Hz search)	
OP4C 10-Hz digit resolution (0.1-Hz search)	
OP4D 1-Hz digit resolution (0.01-Hz search)	
OP4E 0.1-Hz digit resolution (0.001-Hz search)	
OP4F 100-Hz digit resolution (economy, 5-ms switching, 100 Hz Search)	
OP4G 1-Hz digit resolution (economy, 5-ms switching, 100 Hz Search)	

Available for customer installation
Digit Insertion Kit*

1169-9600

* Additional digits of resolution may be added to any synthesizer equipped with options 4A through 4D.
U.S. Patent Number 3,509,483.

(Describe exactly as shown at the left.)

WARRANTY

We warrant that this product is free from defects in material and workmanship and, properly used, will perform in full accordance with applicable specifications. If, within a period of ten years after original shipment, it is found, after examination by us or our authorized representative, not to meet this standard, it will be repaired or, at our option, replaced as follows:

- No charge for parts, labor or transportation during the first three months after original shipment;
- No charge for parts or labor during the fourth through the twelfth month after original shipment for a product returned to a GR service facility;
- No charge for parts during the second year after original shipment for a product returned to a GR service facility;
- During the third through the tenth year after original shipment, and as long thereafter as parts are available, we will maintain our repair capability and it will be available at our then prevailing schedule of charges for a product returned to a GR service facility.

This warranty shall not apply to any product or part thereof which has been subject to accident, negligence, alteration, abuse or misuse; nor to any parts or components that have given normal service. This warranty is expressly in lieu of and excludes all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose, and all other obligations or liabilities on our part, including liability for consequential damages resulting from product failure or other causes. No person, firm or corporation is authorized to assume for us any other liability in connection with the sale of any product.

Introduction—Section 1

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1.1 GENERAL.

The Type 1062 Frequency Synthesizer generates highly stable, accurate frequencies from .01 to 500 MHz at an output level of -7 to $+13$ dBm. The output frequency is derived from a single source by a series of arithmetic operations on frequency (addition, subtraction, multiplication, and division). Phase-locked oscillators are used for stepped-digit frequency selection, except for the 100 MHz steps, where a drift-canceled varactor-tuned oscillator is used.

A continuously adjustable decade, hereafter referred to as CAD, is a built-in feature. The frequency of the selected decade is continuously variable or programmable from -1 to $+10$ digits. Any decade 1 MHz and smaller can be "searched" via an external analog voltage. Remote selection of the searched decade is accomplished by programming a 10 in BCD (8 + 2) for that particular decade.

Signal-to-phase-noise ratio is greater than 63 dB for a noise bandwidth that extends from 0.5 Hz to 15 kHz on each side of the output frequency. The signal-to-amplitude-noise ratio is 75 dB for the same noise bandwidth. Frequency programming, at switching speeds of less than 100 μ s per digit, is easily accomplished with BCD control signals.

This synthesizer is structured to permit custom tailoring for a particular need via performance-level and frequency-resolution options. The basic instrument has 10-kHz resolution, a sweep/search capability, programmability, requires an external reference oscillator, and has a blank front panel

(no means of local control). Option 1 is a local-control feature (i.e., a full complement of front-panel, rotary-in-line switches for manual control of output frequency), pushbutton search access with manual continuously variable search controls, and manual control of output level. Option 2A is a room-temperature reference oscillator; 2B is a precision reference oscillator. Option 3 provides phase-modulation capability. Options 4A through 4E provide a choice of 5 resolutions with 100 μ s programming-response time. Options 4F and 4G are the same as 4B and 4D except the programming-response time is limited to 5 ms and there is no search provision other than that provided by the basic instrument. (Refer to the specifications for details).

A variety of applications exist for the synthesizer in advanced communications, spectrum analysis, physical, medical, and other areas of research. Applications information can be found in the GR reprint Form Number 3218-A, available upon request to General Radio Company.

1.2 DESCRIPTION

1.2.1 Electrical.

Instead of substituting a variable oscillator for a decade digit, as many other synthesizers do the 1062 uses its oscillators in an unlocked mode to superimpose a variable-frequency component on the output of a selected digit.

Any decade with 1 MHz and smaller steps can be "searched" via an external analog voltage. The frequency of the selected decade is continuously variable from its -1 to $+10$ digit. The voltage required varies from -0.5 V to $+5$ V for the -1 to $+10$ digit range. When the 10-kHz/step decade is "searched", the basic 1062 has 100-Hz settability.

In other words, the search feature extends the resolution (stability) of the synthesizer to 1% of the smallest decade step.

The (remote) selection of the decade "searched" is accomplished by programming a 10 in BCD for the particular decade.

With the FREQUENCY SELECT control set to LOCAL (option-1 instrument) the output frequency is selected by the front-panel controls. In the REMOTE position, frequency selection is by 8-4-2-1 binary-coded decimal (search :8 + 2). Negative logic is used and the logic levels are: 0 = 5 V at 0 mA; 1 = 0 to 0.5 V at 3 mA. These levels are compatible with standard TTL integrated logic circuits.

For the basic instrument the -7 to +13 dBm output is controlled via a rear-panel BNC input, and leveled to within ± 1 dB. The RMS output level is related to the program voltage by a factor of 1/4. For example, a voltage of 4.0 V will produce an output of 1.0 V rms or +13 dBm (1.0 V into 50 Ω is +13 dBm).

For option-1 instruments, the output level is 0.1 to 1.0 V (-7 to +13 dBm) from a 50- Ω source impedance. It is available at a front- or rear-panel GR874® recessed locking coaxial connector. The level is continuously adjustable over a 20-dB range providing ± 1.5 dB accuracy. At full output the response is flat within ± 0.6 dB.

An external source is required to drive the basic (or slave-version) instrument. It can be a synthesizer containing option 2A or 2B, another slave version, or any other precision 5- or 10-MHz source. Any number of slave synthesizers can be cascaded, if the first one is driven by a suitable external source.

An instrument containing option 2A has a room-temperature reference oscillator with a stability factor of $2 \times 10^{-7}/^{\circ}\text{C}$ from 20°C to 50°C. The electrical adjustment range is 5×10^{-6} from +6 to +9 Vdc. If better accuracy is required, this oscillator can be switched out and replaced by an external source.

An instrument containing option 2B has a precision reference oscillator with a stability factor of $2 \times 10^{-10}/^{\circ}\text{C}$ from 0°C to 50°C. The electrical adjustment range is $> 5 \times 10^{-7}$ from +6 to +9 Vdc. Drift is $\leq 1 \times 10^{-8}$ /week; approximately 1×10^{-9} /day after 1 month of continuous operation. Within 2 hours after a power interruption, the oscillator will restabilize typically to within 1×10^{-8} . This unit can also be switch substituted.

The external source referred to above must be either 5.0 or 10.0 MHz and its level 0.13 to 2.5 V (-5 to +21 dBm) into 50 Ω . A rear-panel BNC jack provides the connection.

A rear-panel input (labeled PHASE MOD IN) is used to allow modulation of the carrier (option-3 instrument only). Phase modulation is a type of fm where the frequency deviation and the rate are interdependent. In other words, the frequency and amplitude of the modulating signal determine the fm deviation. The relationship is dependent

upon the phase-modulation characteristics. For example, the output can be phase modulated ± 3 radians from dc to 300 kHz. In terms of fm, this means that if you modulate with a 1-kHz signal (rate) at the maximum ± 3 -V amplitude, the equivalent fm deviation is ± 3 times 1 kHz or ± 3 kHz.

There are two types of resolution options. Options 4A through 4D are referred to as standard options; 4F and 4G are "economy" options. They cannot be mixed because separate mother boards are involved. General Radio Company encourages the purchase of option 4A or 4F initially. They include the appropriate mother board and facilitate adding more resolution later without returning the instrument to the factory. Digital-insertion kits are available for this purpose.

It is probably obvious that the resolution options are cumulative. A 1-Hz resolution synthesizer (option 4D) contains the 10-Hz, 100-Hz, and 1-kHz options.

1.2.2 Mechanical.

Large in-line numerals behind windows in the front panel indicate the manually-selected frequency.

The instrument is available in either a bench cabinet or an EIA standard RS-310, 19-in. relay rack. Mounting instructions are given in Section 2 and include converting from one model to the other.

1.3 CONTROLS, INDICATORS, AND CONNECTORS.

Tables 1-1 and 1-2 list and describe the front- and rear-panel controls, indicators and connectors. Refer to the illustrations of Figures 1-1 and 1-2.

1.4 SYSTEMS.

Since additional equipment can expand the basic capabilities of most General Radio instruments, including the synthesizer, arrangements are available to supply complete systems; inquiries are invited. Each system, custom tailored to individual requirements and including only the equipment necessary to perform the required task, is completely assembled and checked as a unit. Such systems have wide application and can be used for laboratory development, production monitoring, final quality assurance, production-lot sorting, incoming inspection, environmental testing, reliability evaluation, etc., on an automatic or semi-automatic basis.

1.5 ACCESSORIES SUPPLIED.

Table 1-3 lists the accessories supplied with the Synthesizer.

1.6 ACCESSORIES AVAILABLE.

1.6.1 Programmable Attenuator — Type 1452.

The GR 1452 programmable coaxial attenuator can be used to attenuate the synthesizer output by known amounts

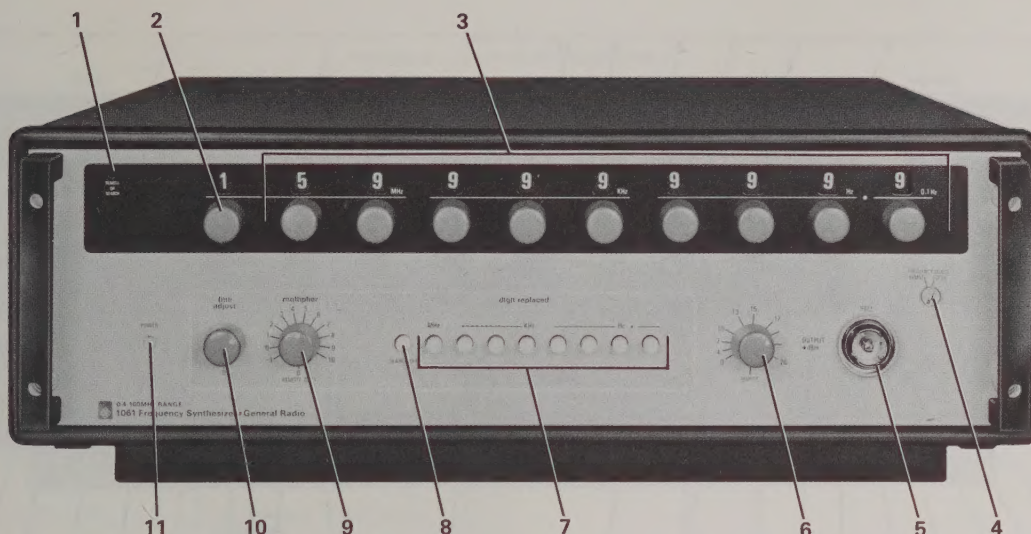


Figure 1-1. Front panel controls, connectors and indicators for synthesizer with option 1.

Table 1-1

Fig 1-1 Item	Name	Description	Function	Remarks
1	REMOTE OR SEARCH	Red panel lamp	NOTE Items 1-10 characterize option-1 instruments. Indicates remote or search operation	Lights when FREQUENCY SELECT control is set to REMOTE or a SEARCH pushbutton is depressed.
2 and 3	—	Frequency knob/dial assemblies. (Item 2) has 2-pos. switch; (item 3) has 10-pos. switches.	(Item 2) provides local control of most-significant digit; (item 3) all other digits.	Not effective in REMOTE mode of operation.
4	FREQUENCY SELECT	Switch, 2 pos., labeled: REMOTE, LOCAL.	Selects local or remote frequency control.	Energizes REMOTE lamp when set to REMOTE.
5	OUTPUT 50 Ω	GR874®, low-loss, quick-connect connector.	External connection for output signal.	May be alternatively mounted on rear panel.
6	OUTPUT dBm	Calibrated rotary potentiometer, panel marked from extreme ccw position: REMOTE, -7, -3, 0, +3, +6, +8, +10, and +13.	Controls and indicates the r-f output voltage into 50 Ω.	REMOTE position transfers control to rear-panel BNC connector (Item 17).
7	Digit Replaced, Hz	Pushbutton switches; panel marked: X.1, X1, X10, X100 Hz; X1, X10, X100 kHz, and X1 MHz.	Replaces step digit indicated by panel marking with continuously adjustable search/sweep capability.	Range of frequency control of selected decade is -1 to +10 times the replaced step digit.
8	SEARCH OFF	Pushbutton switch	Disables the search capability by releasing all digit replaced buttons when depressed.	
9	Multiplier	Calibrated rotary potentiometer. Panel marked: REMOTE ONLY, -1, 0, 1, 2, 3, . . . 9, 10.	Controls and indicates the replaced digit.	Multiply the pushbutton-selected digit-replaced value by the setting of this control.
10	Fine Adjust	Rotary potentiometer, continuously adjustable, "0" position indicated by panel marking.	Uncalibrated vernier on above.	Use to obtain the ultimate settability of frequency. Set to 0 for max multiplier accuracy.
11	POWER	White panel lamp	Indicates instrument is on.	Turn-on accomplished when line cord is connected. There is no power switch.

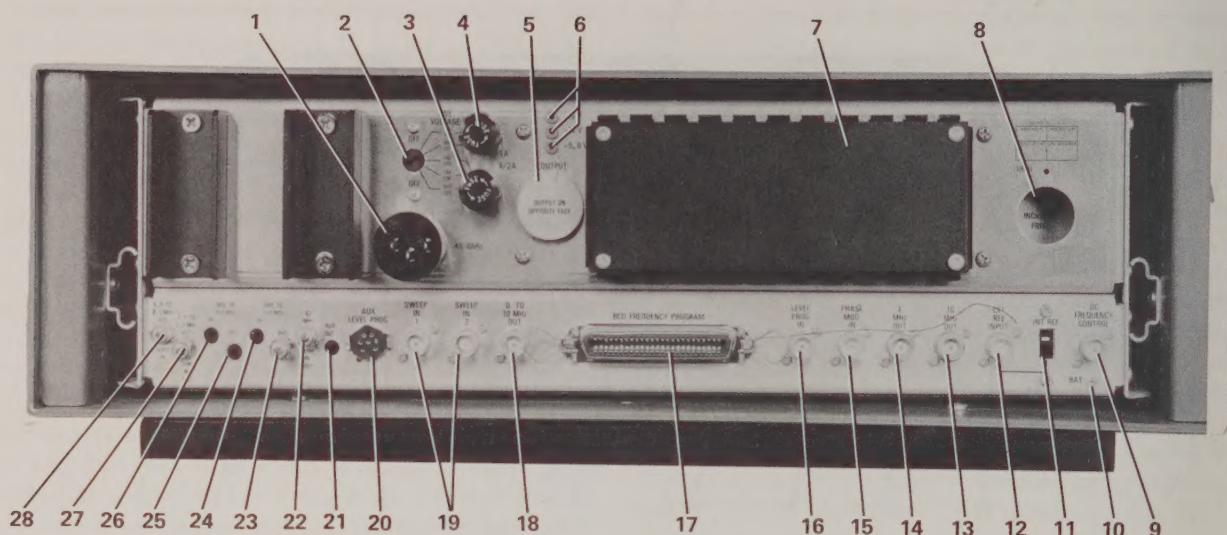


Figure 1-2. Rear apron controls and connectors.

Table 1-2

Fig 1-2 Item	Name	Description	Function	Remarks
1	—	Safety type line-voltage plug, 3-wire (IEC Standard)	Accepts 3-wire ac-line cord, Belden SPH-386 or equivalent	Use GR Power Cord P/N 4200-9625
2	LINE VOLTAGE	Rotary switch, 7 position	Switches line-voltage connection to one of 5 ranges or off.	Panel labeled: OFF, 90-110, 104-127, 180-220, 194-236, 207-253, and OFF.
3	FUSE/½ A	Extractor-post, fuse holder	Protects instrument on 3 highest line-voltage ranges.	
4	FUSE/1 A	Extractor post fuse holder	Protects instrument on 2 lowest line-voltage ranges.	
5	—	Removable disc	Used to cover vacant front- or rear-panel OUTPUT connector hole.	Labeled: output on opposite face.
6	—	Pin jacks, 0.80 in. dia.	Three power supply test points	Panel labeled: +18 V, -12 V, and +5.6 V.
7	—	Metal cover	Cover for power transistors and power-supply adjustments.	Remove cover to obtain access to the power transistor or the +18 V, -12 V, and +5.6 V adjustments.
8	—	Screwdriver-type adjustment	Frequency adjustment for reference oscillator.	Option 2B instrument only.
9	DC FREQUENCY CONTROL	BNC jack connector	Input connection for dc control of internal reference oscillator frequency.	+6 to +9 V, internally biased to +8 V. $\Delta F > 5 \times 10^{-6}$, op2A-, $\Delta F > 5 \times 10^{-7}$, op 2B.
10	BAT	Pin jacks, .08 in. dia.	External battery connection to maintain constant crystal oven temperature in the reference oscillator during power interruption.	15-18 V, 0.2 A max.
11	INT/EXT REF	Slide switch, 2-position.	Permits a choice of internal or external drive.	Disconnects internal reference oscillator when set to EXT REF INPUT position.
12	EXT REF INPUT	BNC jack	Input connection for external reference oscillator.	A 5- or 10-MHz external standard at 0.13 V to 2.5 V into 50 Ω .
13	10 MHz OUT	BNC jack	Connection for 10-MHz output signal	Derived from reference-oscillator source. Level is 0.5 V $\pm$ 20% into 50 Ω .

Table 1-2 (cont)

Fig 1-2 Item	REAR-PANEL CONTROLS AND CONNECTORS			
	Name	Description	Function	Remarks
14	1 MHz OUT	BNC jack	Connection for 1-MHz output signal	Derived from reference oscillator source. Level is 0.8 V pp into 10 k Ω .
15	PHASE MOD IN	BNC jack	Connection for phase-modulation-input signal.	(see specifications)
16	LEVEL PROGRAM IN	BNC jack	Connection for remote control of output level.	RMS output voltage is 1/4 of positive dc program voltage accuracy is ± 1 dB; level is -7 dBm to $+13$ dBm into 10 k Ω ; less than 100 μ s programming response time to within 1 dB of final value. (See also item 5, front panel.)
17	BCD FREQUENCY PROGRAM	Amphenol, Type 57 connector, 50-pin	Connection for BCD frequency program input signals.	See Figure 2-5.
18	Blank			
19	SWEEP IN	BNC jacks labeled 1 and 2	Connections for 2 summing inputs for external control of sweep.	Range of control is -1 to $+10$ times the replaced stepped digit. Sensitivity is 0.5 V/digit with maximum nonlinearity of ± 0.2 digits. Sweep (FM) rate: 0 to 20 kHz; Distortion 6% max., (3% at 5 kHz).
20	AUX LEVEL PROG	May be specially wired for System applications		
21	BLANK			
22	42 MHz	SMA jack, Terminated in 50 Ω .	Provides output for system applications	These connections may be used as test points to check internal operation in trouble shooting. See detailed block diagram for normal signal levels.
23	500 to 510 MHz OUT	SMA jack	Provides output for system applications	
24	Blank			
25	Blank			
26	Blank			CAUTION Outputs require terminations for proper operation of synthesizer*.
27	2.3 to 2.2 GHz out	SMA jack, Terminated in 50 Ω .	Provides output for system applications	
28	1.8 to 2.2 GHz out.	SMA jack, Terminated in 50 Ω .	Provides output for system applications	

*Terminate with coaxial 50 Ω load in SMA connector series. Use Model 4110-P Mfg. by EMC Technology Corp., 1300 Arch St., Phila., Pa.

Table 1-3

ACCESSORIES SUPPLIED		
Name	Description	Part Number
Power Cord	7-feet, 3-wire	4200-9625
Coaxial Patch cord	3-feet, Type 874-R22LA	0874-9683
FREQ PROGRAM Connector	50-pin, Amphenol ^{a, b} Type 57	Amphenol P/N 57-30500

in response to binary coded control signals (or front-panel switch settings). The resolution of the instrument — smallest calibrated step — is 1 dB; the total attenuation is 80 dB and the operating frequency range is 10 kHz to 500 MHz. The accuracy of the attenuator, over the frequency range of the synthesizer, is approximately 1% of setting + 0.4 dB.

1.6.2 Coaxial Adaptors.

As with similar General Radio equipment, the synthesizers use the quick-connect GR874 coaxial connector. However, for the user wishing to mate the instruments with components fitted with coaxial connectors of some other series, it is a simple matter to adapt to that series.

GR874 adaptors to leading commercial and military coaxial series (or to binding posts) are available to convert to the desired type. These adaptors are listed in Table 1-4.

Over-all VSWR of the converted GR874 connector is

typically no greater than that of the other-series connector by itself, and leakage at the GR874 junction is typically >120 dB down.

1.6.3 75-Ω Matching Pad.

The Type 874-MP Matching Pad is a two port, minimum loss, resistive network with a typical loss of 5.72 dB. Each end of the pad is fitted with a GR874 locking connector. The principal application is the conversion of the GR874 OUTPUT connector of the synthesizer from a 50-Ω to a 75-Ω impedance.

The frequency range of the pad is dc to 1 GHz and it can be used to 8.5 GHz. The maximum power rating is 1 W continuous.

For more information on a complete line of coaxial adaptors, consult your General Radio catalog.

Table 1-4
GR874 ADAPTORS

TO TYPE		TYPE 874†	GR PART NUMBER
APC-7		QAP7L	0874-9791
BNC	plug	QBJL	0874-9701
	jack	QBPAL	0874-9801
GR900®		Q900L	0874-9709
N	plug	QNJL	0874-9711
	jack	QNPL	0874-9811
SMA	plug	QMMJL	0874-9723
	jack	QMMPL	0874-9823

† Locking GR874 Connector.

Example: To connect Type 874 to a type-N jack, order Type 874-QNPL

Installation—Section 2

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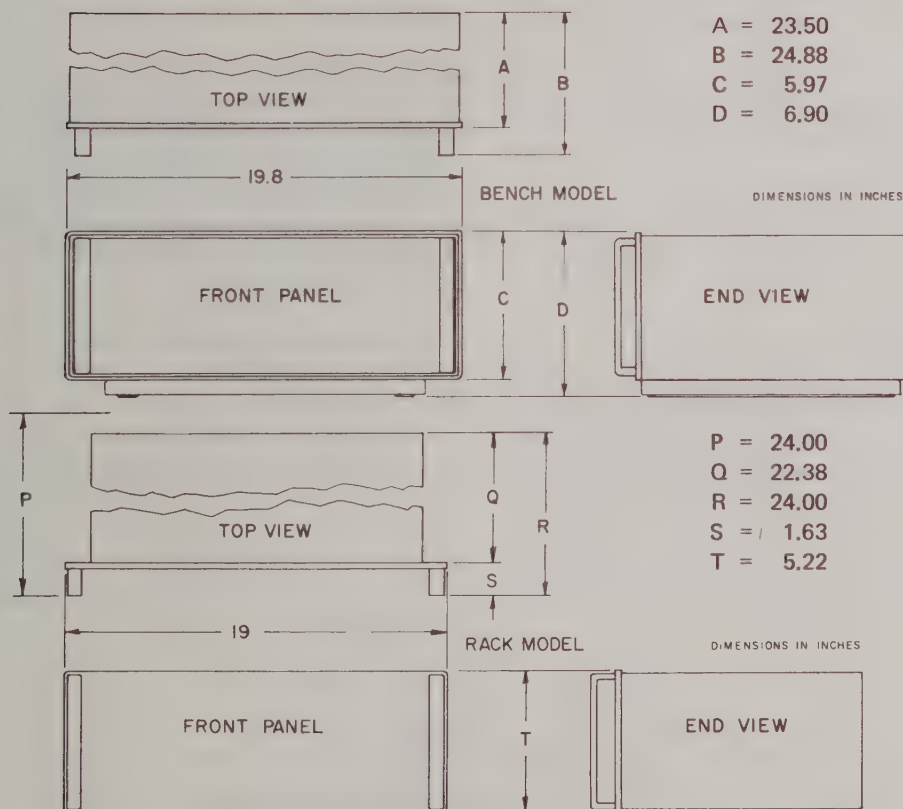


Figure 2-1. Dimensions of the Synthesizer (inches).

2.1 DIMENSIONS.

Dimensions of the rack and bench models are shown in Figure 2-1.

2.2 MOUNTING.

2.2.1 General.

The unit is available in two models, bench mount and relay-rack mount, either of which can be converted to the other by the installation of a simple conversion set.

2.2.2 Bench Mounting.

•• The bench-mount cabinet is made of formed and welded 1/8-in. aluminum finished in baked-on, medium gray crackle paint and has a tilt base. The instrument is retained in the case by four front-panel screws accessible through holes in the carrying handles. To remove the instrument from its case, remove the four front-panel screws and withdraw the instrument. Slide blocks on the instrument engage tracks in the case to guide insertion and withdrawal.

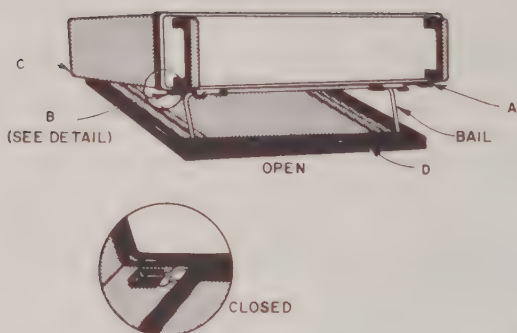


Figure 2-2. The bail can be used to tilt the instrument, providing a better view of the front-panel indicators.

To insert the instrument into the case, straddle the tracks with the rear guide blocks and push all the way into the case. Secure the four front-panel screws.

WARNING

When tilting the instrument or removing the tilt, do not allow your fingers to come between the cabinet and its base.

2.2.3 Tilting.

The bench models of the synthesizer are delivered completely assembled in a metal cabinet, ready for bench use. A convenient bail, located along the bottom front edge of the instrument, can be pulled down to raise the front and provide a better view of the front-panel indicators (see Figure 2-2). To tilt the instrument, proceed as follows:

- Place the right thumb on the right-hand release toggle (A) and the left thumb on the left-hand release toggle (B) under the front corners of the instrument.

- Push both release toggles toward the rear as far as they will go.

- Using the rear of the base (C) as a pivot, lift the front of the instrument, permitting the bail to drop down on the base.

- With one hand, hold the instrument in the tilted position; with the other, pull the bail forward as far as it will go and carefully lower the instrument. The bail is now locked in place and the instrument will remain in the tilted position.

Reverse this procedure to eliminate the tilt. Be sure the toggles are pushed back, toward the rear of the instrument. Then lower the front carefully onto the base. Lock the base to the bottom of the instrument by sliding the toggles (A and B) forward.

2.2.4 Cabinet Removal.

To remove a bench-model instrument from its cabinet:

Remove the four panel screws (A, Figure 2-3), P/N 7270-6310, two on each side of the front panel. These are No. 10-32, 9/16-in. screws, with nylon washers. To loosen them, insert a Phillips-head screwdriver through the holes in the handles, shown in the figure. Then pull the instrument forward, out of the cabinet.

2.2.5 Conversion to Rack Mounting.

The following procedure is used to convert a bench model to a rack-mounted model.

- Order rack-cabinet assembly (P/N 4174-3743), a hardware set (P/N 4174-2002), and a rear cover (P/N 4171-1169), and rear brackets (P/N 4179-8803).
- Disconnect any external cables, remove the front-panel screws and withdraw the instrument from the case.
- Install the rack-cabinet in the relay rack and insert the instrument.

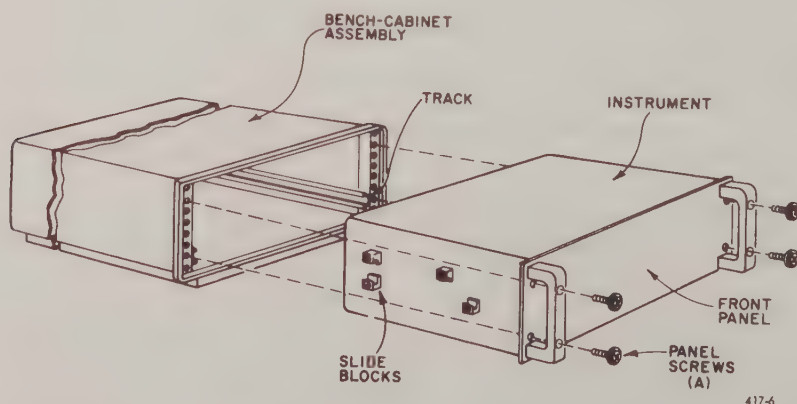


Figure 2-3. Bench cabinet assembly.

2.2.6 Rack Mounting.

A rack-mounting case (Figure 2-4) with installation hardware is provided with a rack-mount model. To install this model in a standard 19-in. relay-rack proceed as follows:

a. Remove the panel screws and withdraw the instrument until it stops. Lift the front and withdraw completely from the cabinet.

b. Insert the cabinet into the rack and secure it to the front of the rack with the four screws provided.

c. If the rack contains a rear support, remove the rear-cover screws and the rear cover from the case. Attach the brackets to the inner holes on the cabinet with the rear bracket screws and nuts provided. Use the set of slots that most nearly align the bracket with the rear support of the rack. Secure the brackets to the rack, each with two screws and nuts provided.

d. Push the track all the way into the case. Place the rear of the instrument into the cabinet, lifting it to straddle the tracks with the slide blocks. Push the instrument into the case until it stops. Lift the front, pull the instrument out so that the tracks follow and then push in so that the front slide blocks straddle the tracks. Slide the instrument all the way into the case and secure with four front-panel screws.

2.2.7 Conversion to Bench Mounting.

a. Order a 4173-4014 bench cabinet assembly (includes hardware set).

b. Disconnect any cables from the instrument, remove the front panel screws and withdraw the instrument from the rack cabinet.

c. Insert the instrument into the bench cabinet, straddling the tracks with the slide blocks. Secure the instrument with the four front-panel screws.

2.3 REMOTE PROGRAMMING CONNECTIONS.

2.3.1 General.

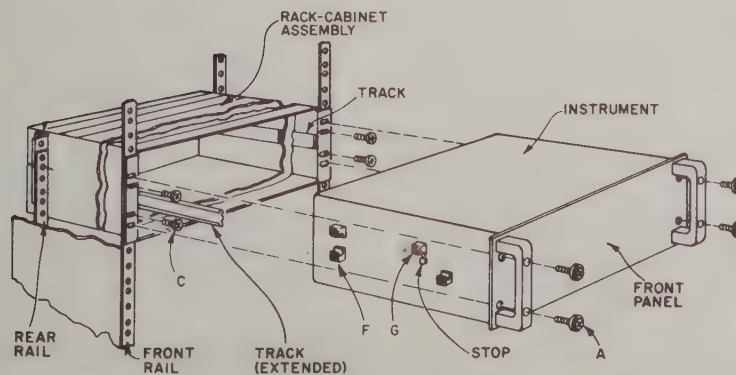
Both the master and slave versions of the unit can be programmed for remote control of output frequency and output level. Table 2-1 lists the three variations of the remote control mode.

Table 2-1
REMOTE-CONTROL-MODE
VARIATIONS
OUTPUT

Frequency	Voltage
Local	Remote
Remote	Local
Remote	Remote

2.3.2 BCD FREQUENCY PROGRAM Socket.

Frequency programming connections are made to the rear-panel BCD FREQUENCY PROGRAM socket (Figure 1-2). This 50-pin Amphenol Type 57 socket (GR P/N 4230-4049) mates with a 50-pin Amphenol Type 57 plug (Amphenol P/N 57-40500).



417-5

Figure 2-4. Method of mounting the relay-rack model.

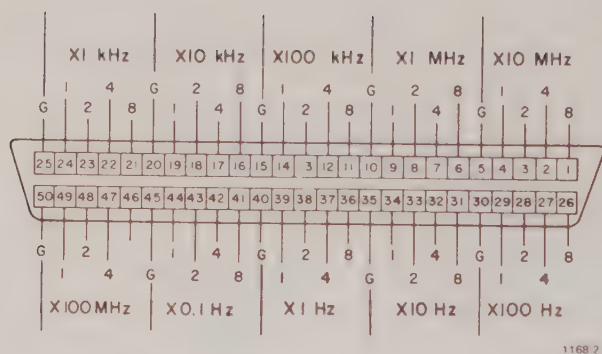


Figure 2-5. BCD FREQUENCY PROGRAM socket connections as viewed from the rear of the instrument.

The information provided in Figure 2-5 can be used to assemble a cable through which the synthesizer can be programmed. Connections can be made with any electrical wire or cable but it is recommended that 4-wire shielded cable be used — a separate one for each frequency decade. A separate ground terminal is provided adjacent to each group of four terminals, which can be used for connecting the shield of each cable. Cable resistance is completely negligible for lengths up to 100 ft.

The color-coding of the recommended cable-conductors should match the 1-2-4-8 code (brown, red, yellow, and grey) for easy identification within a cable. It is suggested that the individual cables be marked with color bands at each end to identify the rank of the decade it connects.

A strain relief should be used under the plug clamp to relieve the cable of strain and to avoid pinching the wires when the clamp is tightened. A simple strain relief can be made by wrapping electrical tape around the cable assembly and tightening the clamp around the tape.

All external frequency selection is by 1-2-4-8 BCD control with external program connections provided by a rear-panel multiple contact plug. Logic levels are +5 V for logic "0" and +0.5 V or less for logic "1". An internal 2-k Ω pull-up resistor is provided to keep all program lines at logic "0" unless the external circuit is completed to ground; 3 mA or less will program a logic 1. These levels are compatible with external DTL or TTL integrated circuit gates or inverters.

The switching speed for 10-kHz and above is < 100 μ s; below 10 kHz steps it is also < 100 μ s, except for economy resolution options 4F and 4G, where it is < 5 ms.

2.3.3 LEVEL PROGRAM Connector.

The output level is set by an external dc signal applied to the rear-panel LEVEL PROG IN connector and 4x the

desired rms output voltage. Programming response time is < 100 μ s to within ± 1 dB of the desired level. The input impedance is 10 k Ω . The synthesizer output into 50 Ω , from a 50- Ω source impedance, is -7 to +13 dB (or 0.10 to 1.0 V).

2.4 POWER-LINE CONNECTION.

The power-transformer primary windings can be switched, by means of the five-position switch (Figure 1-2) on the rear panel, to accept a line voltages of 90-110, 104-127, 180-220, 194-236, or 207-253 V. Operation at line frequencies up to 440 Hz, with lower line voltage limits increased by 5%, or down to 45 Hz with upper limits reduced by 5%, is satisfactory.

Connect the 3-wire power cable (P/N 4200-9625) to the line and to the 3-terminal male connector (Figure 1-2) on the rear panel. A 1-A fuse is used at the 2 low voltages. A 0.5-A fuse is used at the 3 higher voltages. Power consumption is approximately 70 W.

2.5 LINE-VOLTAGE REGULATION.

The accuracy of measurements accomplished with precision electronic test equipment operated from ac line sources can often be seriously degraded by fluctuations in primary input power. Line-voltage variations of $\pm 15\%$ are commonly encountered, even in laboratory environments. Although most modern electronic instruments incorporate some degree of regulation, possible power-source problems should be considered for every instrumentation setup. The use of line-voltage regulators between power lines and the test equipment is recommended as the only sure way to rule out the effects on measurement data of variations in line voltage.

The General Radio Type 1591 Variac[®] Automatic Voltage Regulator is a compact and inexpensive equipment capable of holding ac line voltage within 0.2% accuracy for input ranges of $\pm 13\%$. It will assure, for example, that an instrument rated for 100-125 (or 200-250) V can be operated reliably in spite of varying input voltages in the range 85-135 (or 170-270) V. The 1 kVA capacity of the 1591 will handle a rack full of solid-state instrumentation with no distortion of the input waveform. This rugged electromechanical regulator comes in bench or rack-mount versions, each with sockets for standard 2- or 3-wire instrument power cords.

2.6 ENVIRONMENTAL CONDITIONS.

The instrument is designed to operate in a relay rack over the ambient air-temperature range, inside the rack, of 0 to 50°C. When mounted in a bench cabinet the outside air-temperature range is 0 to 50°C. The nonoperating

storage-temperature range is -40°C to $+75^{\circ}\text{C}$. Permissible maximum relative humidity of the ambient is 95% with the instrument operating. The instrument will withstand normal shock and vibration encountered in nonmobile applications. With more severe vibration conditions, operation may be satisfactory but the General Radio Company should be consulted for recommendations.

2.7 EXTERNAL CONNECTORS.

2.7.1 External Battery Connector.

A pin jack connector, marked BAT, on the rear apron permits a "keep alive" battery (*not supplied*) to be connected to the crystal oven. Any 15 V to 18 V nickel cadmium battery is sufficient.

If used, the battery will maintain the crystal oven temperature in case of a power interruption. Internal diodes isolate the battery during normal operation and provide automatic switchover if ac power is removed.

2.7.2 Level Program.

The output level is set by an external dc signal applied to the rear-panel LEVEL PROG IN connector that is 4X the desired rms output voltage. Programming response time is $<100\ \mu\text{s}$ to within $\pm 1\ \text{dB}$ of the desired level. The input

impedance is $10\ \text{k}\Omega$. The synthesizer output into $50\ \Omega$, from a $50\text{-}\Omega$ source impedance, is 0 to $+13\ \text{dB}$ (or 0.10 to 1.00 V).

To utilize the level programming feature of an option-1 instrument, set the front-panel OUTPUT control to the REMOTE position. The basic instrument is level programmed.

2.7.3 Sweep In.

Two rear panel sweep input connections are provided. Up to ± 5 volt signals may be simultaneously applied to these inputs with or without the option 1 panel sweep control on its remote only position. The result of all inputs is summed to produce frequency control of the selected digit. If the range of control is exceeded, internal limiting prevents the frequency from being charged beyond allowable limits. As a result of the summing feature a small amount of fm can be superimposed on a steady dc offset provided by the panel control or a dc input signal; or two f-m rates can be simultaneously applied. The sensitivity to either rear panel input is a frequency change equal to one digit step for each 0.5 V increment applied, zero digit frequency occurring when the sum of all inputs is 0 V. The input impedance at each input is $30\ \text{k}\Omega$.

Table 2-2
AVAILABLE INTERCONNECTION ACCESSORIES

	776-A	Patch cord, shielded double plug to BNC plug, 36" long	0776-9701
	874-R22A	Coaxial patch cord GR874 to GR874, 36" long	0874-9682
	776-B	Patch cord, GR874 (right-angle) to BNC plug, 36" long	0776-9702
	776-C	Patch cord, BNC plug to BNC plug, 36" long	0776-9703
	776-D	GR874 to GR874, both right-angle, 36" long	0776-9704

274-13XA

Operation—Section 3

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3.2 INSTRUMENT TURN-ON	3-1
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3.4 OPERATIONAL CHECKS	3-1
3.5 MODES OF OPERATION	3-2

CAUTION

Do not connect the power cord until the line-voltage switch has been properly set.

3.1 PRELIMINARY CHECKS

Refer to the previous section for a list of the connectors and for tabulation of their functional descriptions. The recommended initial operating procedure follows:

a. Check that the rear-panel line-voltage switch is positioned according to the available power-line voltage. Use the tip of a small screwdriver to turn the switch cw or ccw. The line-voltage frequency must be in the range of 48-66 Hz (except for limited voltage range).

b. Connect the power plug (rear panel) to a suitable power line, using the power cord supplied. The instrument is now on and the front-panel POWER lamp should glow — there is no power switch.

3.2 INSTRUMENT TURN-ON

Because a crystal oven should operate continuously, an on-off power switch is not provided with the synthesizer. Instrument turn-on is accomplished by connecting the a-c line to the rear-panel power connector.

The OP2B synthesizer uses a built-in precision quartz-crystal oscillator for its internal driving source. This crystal is housed in a temperature controlled oven, for optimum oscillator stability, and has a relatively long warm-up interval if the power is interrupted. A rear-panel connector is provided for connecting an external battery to the crystal oven. This connection may be desirable in case of a power failure or if for some reason the unit has to be turned off.

3.3 INSTRUMENT WARM-UP

Since the unit is all solid-state, except for the indicator lamps, no warm-up time is required to generate output. However, in applications where the synthesizer is phase-locked to an already operating external standard, it is necessary to allow complete equipment warm-up to a steady-state condition, if the ultimate in stability is required.

NOTE

Very small frequency errors, due to phase drifts of tuned circuits in the synthesizer, can be important in some demanding applications.

For extremely precise work, a warm-up period of 2 hours or more is recommended for the precision oscillator. When feasible, round-the-clock operation is desirable if high precision is apt to be required on short notice.

3.4 OPERATIONAL CHECKS

NOTE

All operational checks given below assume a remote-only version of the synthesizer or a manual control option instrument set for remote control. It is probably obvious that the checks can be even more readily performed if a manual-controlled instrument is to be checked.

3.4.1 General.

These procedures can be used for incoming inspection, operator familiarization, or as a periodic check on instrument operation.

3.4.2 Proper Frequency Generation

For a quick check of proper frequency generation, use the following procedure:

- Connect the OUTPUT connection to INPUT A of the 1191/Z Counter. Use a GR 874-QBPAL adaptor and a 776-C patch cord.
- Using one or more clip leads, ground the various pins of the frequency program plug so as to set the output frequency between 0.4 MHz and 160 MHz.
- Observe the counter visual register. It should display the same frequency set by the frequency program lines.

3.4.3 Sweep Check

(Figure 2-5)

A center frequency of 10 MHz and a sweep width of 20 kHz are used as an example for this check. Other sweep-width combinations will do as well. A manual sweep, rather than a repetitive sweep voltage, is used so that the output frequency can be read on the counter.

- Set the frequency program lines for a center frequency of 10 MHz (ground pin No. 4).
- Program a 10 at the 10-kHz decade (ground pins No. 16 and No. 18).
- Connect the 1191-Z Counter to the OUTPUT connector.
- Apply a variable dc voltage from 0 V to +1 V at SWEEP IN 1 and observe the output frequency. The frequency should change from 10.000 to 10.020 MHz. Repeat the measurement using the SWEEP IN 2 connection.

The above procedure can be used for any desired combination of sweep width control settings, as long as the counter resolution is sufficient to read both extremes of the sweep frequency.

3.4.4 OUTPUT Voltage Level

- Set the synthesizer to any frequency within its output-frequency range.
- Connect the GR 1806 Electronic Voltmeter, by its -P1 Probe and probe tee terminated in a GR 874-W50BL, 50- Ω termination to the synthesizer OUTPUT connector.
- Apply a d-c voltage to the synthesizer LEVEL PROG IN connector for maximum output (+4.00 Vdc, +13 dBm = 1.0 V, rms).
- Observe the 1806 indication, which should be within 10% of $\frac{1}{4}$ the applied dc voltage.

3.4.5 Frequency Programming

A switch or solid-state closure to ground will change the

program lines from the "0" state to the "1" state. The frequency programming circuits can be functionally checked with a counter and a test lead that has a probe on one end and a clip on the other.

For example, adjust the controls for remote frequency operation and connect the 1191/Z counter to the output connector. Pick a frequency within the frequency range of the synthesizer and refer to Figure 2-5 for its corresponding terminal number. For this example we will use 10 MHz. Clip one end of the test lead to the chassis and touch the probe to terminal 4 of the BCD FREQUENCY PROGRAM socket. Observe the 10-MHz reading on the visual register of the counter. Note that the count disappears as soon as the short to ground is removed. This happens because all lines maintain logic 0 unless a closure to ground is made.

3.5 MODES OF OPERATION.

3.5.1 General.

In addition to using the master oscillator as the internal precision frequency source, it can be replaced by an external frequency standard. The sweep capability can be switched on or off and over-all instrument operation can be locally (manually) or remotely controlled.

3.5.2 Master Oscillator.

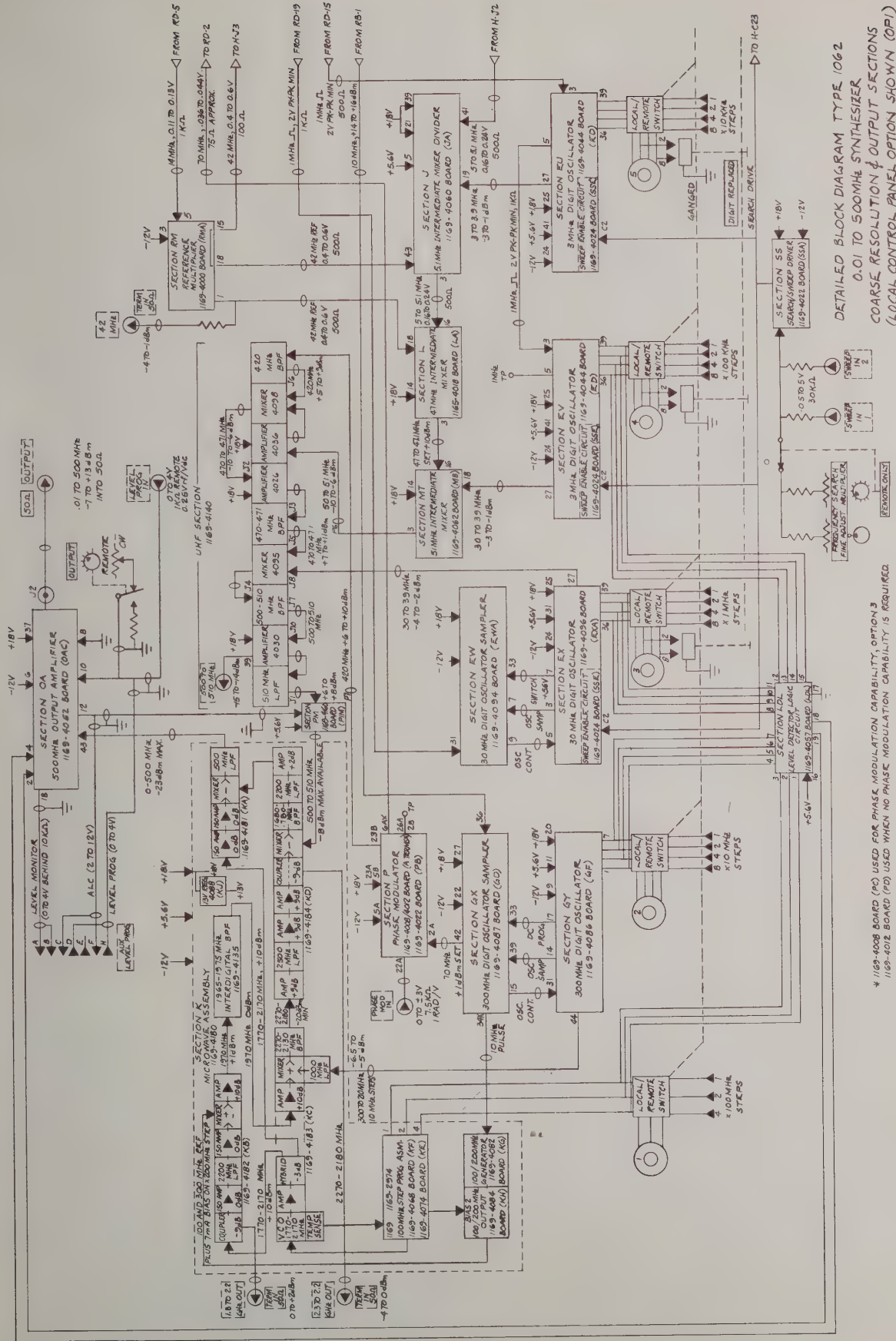
Internal Drive. In this mode of operation, the internal master oscillator is used as the synthesizer driving source and determines the output frequency stability. To use the oscillator in this manner, set the rear-panel switch to the INT REF position (white marker up).

External Drive. Setting the rear panel slide switch down to EXT REF INPUT disables the internal oscillator and connects the rear-panel connector directly to an amplifier, in the synthesizer. This method of operation is useful in case of internal oscillator failure or power interruptions that impair oscillator stability. With no internal oscillator, this is the only means of operation.

Make the connection and set the control as follows the external-drive operation:

Slide Switch		EXT REF INPUT
EXT REF INPUT	. . .	Connect a 5-MHz or 10-MHz Precision Source**

**The external drive level must be 0.13 V or 2.5 V into 50 Ω at rear panel BNC Connector.



* 1169-4082 BOARD (PC) USED FOR PHASE MODULATION CAPABILITY, OPTION 3
 1169-4012 BOARD (PD) USED WHEN NO PHASE MODULATION CAPABILITY IS REQUIRED

Block diagram — Part 1 — coarse resolution and output sections (1 of 2).

DETAILED BLOCK DIAGRAM TYPE 1062
 0.01 TO 500 MHz SYNTHESIZER
 COARSE RESOLUTION & OUTPUT SECTIONS
 (LOCAL CONTROL PANEL OPTION SHOWN (OP1))



General Radio

300 BAKER AVENUE, CONCORD, MASSACHUSETTS 01742

*NEW YORK

Delaware, New Jersey, New York, Eastern Pennsylvania
380 Midland Avenue, Saddle Brook, NJ 07662
Telephone: (NJ) 201 791-8990 (NY) 212 964-2722
TWX: 710 988-2205

*BOSTON

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Maryland, Virginia, West Virginia, (Wash. D.C.)
15 Firstfield Road, Gaithersburg, MD 20760
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Telephone: 214 234-3357, (HOUSTON) 713 464-5112

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Irvine Industrial Complex, Irvine, CA 92705
Telephone: 714 540-9830 • TWX: 910 595-1762

*SAN FRANCISCO

Northern California, British Columbia, Idaho, Montana, Oregon, Washington, Utah
1050 East Meadow Circle, Palo Alto, CA 94303
Telephone: 415 948-8233 • TWX: 910 373-1203
Alaska 907 279-5741

CANADA

*General Radio Canada Limited

307 Evans Avenue, Toronto, Ontario M8Z 1K2
Telephone: 416 252-3395 • TELEX: 02-29294
Montreal 514 737-2126 • Ottawa 613 233-4237

EUROPE, AFRICA, and NEAR EAST

*General Radio Company (Overseas)

P. O. Box, CH-8034 Zurich, Switzerland
Telephone: (01) 55 24 20 • TELEX: 845-53638

ASIA, PACIFIC, and LATIN AMERICA

General Radio International Division

Concord, Mass 01742
Cable: GENRADCO CONCORD (Mass) • TELEX: 094-594

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